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US ARMY
LABORATORY COMMAND

CONTRACT REPORT NUMBER 4-91
PREPARED FOR THE
HUMAN ENGINEERING LABORATORY

BY

ASI SYSTEMS INTERNATIONAL
Aberdeen Group
211 West Bel Air Avenue
Aberdeen, MD 21001

PHASE II DESIGN INTERMODAL
AMMUNITION CONTAINER (AMCON)
FIELD TEST

FINAL REPORT

Contract Number DAAD05-89-C-0071

March 1990

US ARMY HUMAN ENGINEERING LABORATORY
HEL
ABERDEEN PROVING GROUND, MARYLAND

ABERDEEN PROVING GROUND, MARYLAND 21005-5001

ASI 90-02

PHASE II DESIGN INTERMODAL AMMUNITION CONTAINER (AMCON) FIELD TEST

Contract Number: DAAD05-89-C-0071

FINAL DRAFT REPORT

March 1990

By

D. J. Shearin, Sr.

Prepared For:
Combat Service Support Division
U.S. Army Human Engineering Laboratory
Aberdeen Proving Ground, Maryland 21005-5001

ASI SYSTEMS INTERNATIONAL
ABERDEEN GROUP
2 N. Bel Air Avenue, Aberdeen MD 21001

28 MARCH 1990

SUBJECT: Transmittal of Draft copy of ASI Report 90-02, Phase II Design Intermodal Ammunition Container (AMCON) Field Test.

TO: Director
U.S. Army Laboratory Command
Human Engineering Laboratory
ATTN: SLCHE-CS (Mr John J. Salser)
Aberdeen Proving Ground, MD 21005-5001

Dear Mr Salser:

Reference is made to Contract DAADO5-89-C-0071, as amended. The above referenced document calls for the preparation of a final draft report containing the results of field tests of the Phase II Design Intermodal Ammunition Container (AMCON) and the Hooklift Interface Kit (HIK), including an analysis of the test data and recommendations for engineering design changes as appropriate. During a recent IPR, the COTR requested the results of the field testing of the AMCON and HIK be provided as separate reports.

A final draft copy of the HIK field test results, prepared in accordance with above guidance, was forwarded to your organization by letter dated 20 March 1990. A final draft report containing the results of the AMCON field test is enclosed (triplicate) in accordance with above guidance.

Sincerely,

Allan R. Burke, Director
Aberdeen Operations

ARB/djs

ASI 90-02

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PREFACE

The work recorded in this report was authorized under Contract DAAD05-89-C-0071, dated 1 October 1989. Experimental prototype field testing was performed on a Phase II Design Intermodal AmmunitionContainer (AMCON) designed and fabricated by the American Coastal Industries (ACI), Renovo, PA., a subcontractor of the Transport Technology Division of Blair International, Durham, England. Testing was performed at the U.S. Army Human Engineering Laboratory, Combat Service Support Division Logistics Technology Test Site, Aberdeen Proving Ground (Edgewood Area), MD.

ACKNOWLEDGMENTS

The author of this report wishes to extend his thanks and appreciation to Mr John J. Salser, the U.S. Government Principal Investigator and SSG Darrell Cumpton, U.S. Government Associate Investigator for their on-site, "hands on" technical support provided during the conduct of the AMCON tests. This support greatly facilitated the uninterrupted conduct of the field trials and the early dissemination of the results through the timely publication of this report.

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INTRODUCTION

The results of a 1984 worldwide survey of container ports, as reported in Janes' "Freight Containers International Survey of Containers", listed over 350 ports scattered throughout the world that have, or were in the process of constructing container handling facilities. The introduction of round-the-world super ship services during this same period using new, large, container ships and cargo ships converted to container vessels was the final event needed to assure the general cargo shipping industry that containers would dominate future transoceanic shipping. During the past five years, this rapid growth trend has continued. Today, container lifting, handling, and transporting equipment dominates the cargo handling operations of practically all major ports throughout the world. These facilities are continuously being upgraded by adding more and larger Gantry cranes with increased capacities and by interfacing this equipment with intermodal transport systems to provide a ***seamless distribution system.***

The United States shipping industry currently estimates that more than 80 percent of the general cargo being shipped to overseas ports is containerized. All new general cargo ships being built today are designed for the transport of containers and most of the older break-bulk cargo ships have been converted to transport containers. It is recognized by the military that, in the event of a future mobilization, the bulk of military equipment will, through necessity, be containerized. Oversize military cargo unsuitable for containerization will normally be transported by special military vessels or will be transported in the forward bay of a container ship. This bay will typically be of limited capacity. Upon arrival at a port, the noncontainerized, large items such as large trucks and heavy tracked vehicles will be handled "off line" from the primary cargo handling systems. The capabilities of most major ports to handle noncontainerized cargo will be limited, therefore, delays in handling such cargo will be the norm.

The U.S. Army is presently shipping ammunition to overseas theaters of operation via the MILVAN which is a military container intermodally compatible with container vessels. Due to the extremely small number of MILVANs currently available or anticipated in the future in relation to the anticipated requirements in support of a future major AirLand Battle conflict, it is estimated that the current inventory of military containers would be totally committed prior to the end of the first week of mobilization. At that point, the military would be forced to either rely on the private sector to provide the containers required for the uninterrupted movement of military supplies and equipment to overseas theaters of operations or find alternative means for shipping.

BACKGROUND

One of the most critical and heavily consumed military commodities is ammunition. Because of its high priority in any military conflict, several concepts are under study for improving the capability to rapidly move ammunition through the logistics network. Once the ammunition has arrived at the overseas port there is a critical need to move it forward to the battle areas more rapidly and with minimum handling using military transport vehicles.

The Army is presently testing a Palletized Loading System (PLS). The PLS is a 16 1/2 ton capacity cargo vehicle equipped with a unique Load Handling System (LHS). The LHS permits the driver to rapidly upload and download a flatrack loaded with cargo without leaving the vehicle cab. The Project Manager, Ammunition Logistics (PM AMMOLOG), in concert with the U.S. Army Human Engineering Laboratory (HEL), has embarked on a program to develop means of enhancing PLS capabilities. One of these enhancement programs is the development of the Hooklift Interface Kit (HIK) which will give the PLS vehicle the capability of rapidly picking up, transporting, and downloading commercial 8 ft x 8 ft x 20 ft containers without the use of the PLS flatrack. (See ASI Systems International Report 90-01, "Hooklift Interface Kit, Phase II Design Field Test Results", March 1990.) The anticipated critical shortage of MILVAN, and the doubtful availability of suitable commercial containers for the movement of ammunition have caused the PM AMMOLOG and HEL to procure and test experimental prototypes of a special ammunition container called the Intermodal Ammunition Container.

The first prototype (Phase I Design) Intermodal Ammunition Container (AMCON) was fabricated and tested in 1988. Design modifications required as a result of the 1988 testing were incorporated into a second prototype (Phase II Design). Testing of the Phase II version is the subject of this report. For simplicity, the two prototypes will be referred to as the Phase I AMCON and the Phase II AMCON throughout the remainder of this report.

PURPOSE

The purpose of this document is to provide a brief description of the AMCON, a summary of the results of the Proof of Principal field tests of the Phase I AMCON and a more detailed report of the field testing of the Phase II AMCON. EXPLANATORY NOTE: THE SUMMARY RESULTS OF THE PHASE I AMCON EFFORT ARE PRESENTED TO PROVIDE THE READER WITH A COMPLETE KNOWLEDGE OF WORK PERFORMED TO DATE IN A SINGLE DOCUMENT. FOR FURTHER INFORMATION ON THE TEST RESULTS OF THE PHASE I AMCON, SEE ASI REPORT 88-16, "PROOF OF

PRINCIPLE - INTERMODAL CONTAINER/HOOKLIFT INTERFACE KIT (IMCON/HIK) DATED JANUARY 1989, ASI SYSTEMS INTERNATIONAL (AVAILABLE THROUGH THE USAHEL). ALTHOUGH THE PHASE I REPORT REFERS TO THE ITEM AS INTERMODA'. CONTAINER (IMCON), THE NAME WAS SUBSEQUENTLY CHANGED BY THE ARMY TO INTERMODAL AMMUNITION CONTAINER (AMCON).

PART I - RESULTS OF THE PHASE I DESIGN INTERMODAL AMMUNITION CONTAINER (AMCON) TESTS

ITEM DESCRIPTION

The Phase I AMCON is shown at Figure 1. It is fabricated from steel and is 8 ft wide x 6 ft high x 20 ft long. As the name implies, the AMCON is intermodally compatible not only with the container handling cranes at ports and the cells of container ships, but also with the PLS vehicle. Loaded containers can be stacked nine high in the cells of container ships and can be handled by overhead cranes in the same manner as the ANSI ISO commercial container.

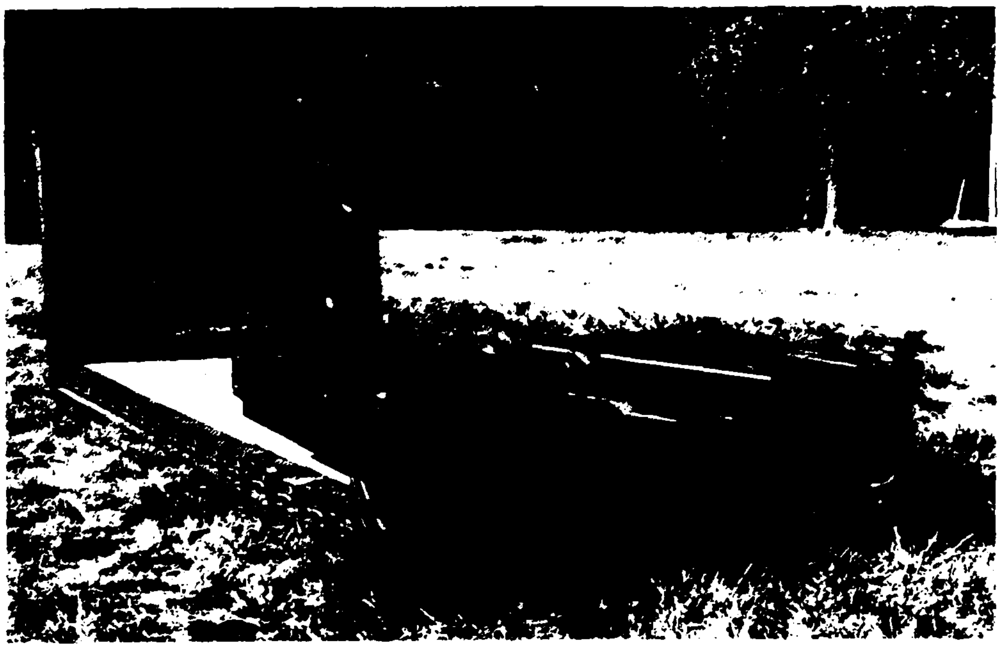

Figure 1. Phase I Design AMCON

The Phase I AMCON has a tare weight of 6062 lb as compared with approximately 5900 to 6000 lb for a typical 8 ft x 8 1/2 ft x 20 ft commercial container. It has an estimated load carrying capacity of approximately 26 tons. The AMCON has been designed with an "A" frame and yoke identical to that of the PLS flatrack so that the AMCON is fully compatible with the Load Handling System (LHS) on the PLS. These AMCON can be uploaded and downloaded directly onto and off of the PLS vehicles without the use of a PLS flatrack. Unlike the PLS flatrack, the two ends of the Phase I

AMCON can be folded inward to conserve space when stacking one on top of another for retrograde and storage purposes. Based on field testing conducted at the HEL Logistics Technology Test Site, Aberdeen Proving Ground (Edgewood Area), MD during the fall of 1988, the mean time to upload a fully loaded Phase I AMCON onto a PLS was 1.68 minutes. The mean time to download the AMCON was 1.66 minutes. These times are very similar to the times required to upload and download the regular PLS flatrack.

SHORTFALLS/DEFICIENCIES

1. Shortfalls/Deficiencies of the Phase I AMCON and Suggested Fixes.

a. The design weight of the Phase I AMCON was to be approximately 5700 lb. The actual weight of the Phase I prototype was 6062 lb. Several recommendations were provided to reduce the overall weight of the container.

b. The contract for the Phase I AMCON contained a "desired" objective that the folding ends of the AMCON be capable of being raised and lowered by one soldier and a "required" objective that the ends be capable of being raised and lowered by two soldiers. During the conduct of field tests, it was difficult for two men to raise either end of the Phase I prototypes. It was concluded that the counterbalancing spring used to assist in raising and lowering the ends required further adjustment and perhaps a different design to reduce the effort required. It was also concluded that a major redesign may be required to enable one individual to raise and lower the ends of the container.

c. The pins used to lock the ends of the container in an upright position could not be fully engaged due to a misalignment of the holes on the ends of the containers. In addition, the alignment process was further aggravated by the fact that the small guide rod welded on the ends of the locking pins had a tendency to bend at the point of weld. It was concluded that this deficiency could be corrected by redesigning the entire pin. The redesigned pin would have approximately the same diameter, would not include the small diameter welded rod on the end, and would incorporate a slight bevel.

d. A protective plate located behind the bail bar was supposed to be fabricated from 1/8 inch steel plate. This was to prevent damage if the driver of the PLS inadvertently backed the vehicle, with the hook of the LHS extended, into the end of the container while uploading it onto the vehicle. The remainder of the end panels were to be

fabricated from a lighter weight corrugated steel material. It was apparent that the entire panel on the ends of the container had been fabricated from 1/8 inch steel plate which contributed to the overall weight of the container and the difficulty in raising and lowering the ends from the horizontal to the vertical position.

e. It was noted that the height from the lower end of the end corner castings to the top of the floor of the container measured 16 1/4 inches as compared with 11 inches for the PLS flatrack. The reason for this increased dimension was not clear.

f. The contract for Phase I prototypes called for the provision of folding "gull wing" aluminum covers to cover the cargo. The center horizontal steel beam used to hold the covers in place was very heavy and unwieldy and could not be raised by two individuals as specified in the contract. The vertical tracks on each end of the container used to guide the center beam from the floor to the "ready" position and the gasket material between each of the sections of the covers were missing. The distance between the end of the center beam and the container end walls was in excess of five inches. This required full extension of the telescope adjustment devices to close the gap. The "play" or looseness of these telescope adjustments allowed the center beam to drop several degrees and resulted in instability of the center beam. Although the design contractor attempted to make several modifications to correct these deficiencies, none were judged to be suitable so further changes in the design of the covers was abandoned. Some of the recommendations provided for a future design included: (1) Install a metal plate at the second fold of each cover to hold the cover in a rigid position when closed, (2) Place an additional beam at the top outside right and left ends of the container to prevent the covers from resting on the cargo, and (3) Replace the excessively heavy rubber hinges between each folding section of the cover with rigid light weight piano type hinges. A photograph of the AMCON with the gull wing covers is shown at Figure 2.

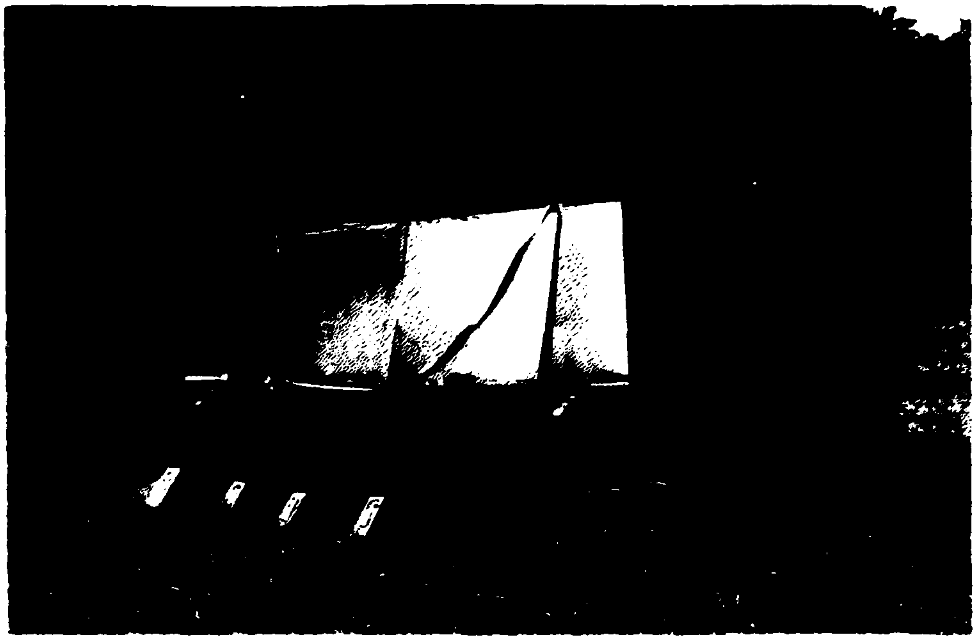

Figure 2. Phase I AMCON with Gull Wing Covers

In view of the many design problems associated with the current design of the gull wing covers, it was recommended that consideration be given to using a design similar to that used for the "Open All" experimental ANSI ISO approved container manufactured by Drehtainer Technik Corporation, Hamburg, Germany. (See photograph at Figure 3). An alternative would be to use a flexible tarpaulin cover locked into position by a series of eye loops through which a case hardened steel cable is run. Both ends of the cable can be secured by the tamper proof seal currently used on open top commercial containers.

Figure 3. Drehtainer Technik Open All Container

2. Conclusions/Findings

a. It was concluded that use of the Phase I AMCON as part of the PLS either in lieu of the current PLS flatrack or as an additional flatrack for the transport of ammunition is feasible and desirable and would result in an enhancement of the performance capabilities of the PLS. The mean time to prepare an AMCON for loading with cargo (raise the two ends from their storage position to a "ready" position and lock them in place) was 0.87 minutes. The mean time to upload an AMCON fully loaded with cargo was 1.68 minutes. The adjusted mean time to download the AMCON was 1.66 minutes. These times are consistent with the times required to upload and download a regular PLS flatrack onto and off of a PLS vehicle. The AMCON offers several advantages over the PLS flatrack in that it is intermodal, is capable of being stacked nine high in the cells of a container ship and, with both ends folded inward, can be stacked and locked together to occupy minimum space during retrograde by PLS vehicles (in a theater of operations) and intermodal container ships (back to the CONUS).

b. The tare weight of the Phase I AMCON was excessive and the structural integrity was significantly in excess of that required, i.e. the design provides a cargo weight capacity of approximately 26 short tons while the cargo carrying design weight of the PLS is only 16 1/2 short tons.

c. The folding ends of the AMCON are heavier than required for structural integrity.

d. The "D" rings used to anchor cargo restraint straps are in a poor location. It was concluded that this was due to a misinterpretation of the drawings by the manufacturer.

e. The current gull wing covers are unwieldy and cannot be raised and lowered by two men as required by the design specification. The overall design is poor. A complete redesign is needed, or an entirely new concept for a cargo cover should be investigated.

f. The fork lift pockets in the base of the AMCON, although in accordance with ANSI ISO container specifications, are too wide for the military rough terrain fork lift and require either redesign or addition of another set of pockets.

3. Recommendations:

a. It was recommended that the Army proceed with the redesign, fabrication and testing of the Intermodal AMCON to eliminate the deficiencies recorded in the test report. After successful testing of the redesigned AMCON, it was recommended that an AMCON be made available to the appropriate U.S. Army Training and Doctrine (TRADOC) organizations such as the Transportation Center and School and Quartermaster Center and School for conduct of additional testing with other classes of supplies. It was further recommended that an AMCON be provided to the Canadian, British and German Armies for conduct of further testing and evaluation.

b. Because the NATO standard locking device on the PLS vehicle (locks the flatrack onto the PLS chassis during transport) permits container pickup from only one end and because the advantages associated with picking up an AMCON from either end were not apparent from an operational point of view, it was recommended that the "A" frame with bail bar be eliminated from the rear end of the next generation AMCON design.

c. It was recommended that one of the folding ends be designed so that it can be folded either inward or outward. When folded outward, it can be used as a ramp to upload disabled vehicles for retrograde thus providing an addition to the PLS and the AMCON performance capabilities.

d. It was recommended that either further redesign of the gull wing cargo covers be abandoned in favor of a complete redesign similar to that of the German manufactured "Open All" container, or that flexible tarpaulin covers presently in use by the private sector for covering and securing cargo shipped in open top containers be used.

e. The "D" rings, welded to the outer edges of the "I" beam forming the outer framework for the floor of the container, used as anchor points for the cargo restraining straps were mounted too far inward from the outer edges of the beam. This made it difficult to engage the hooks of the restraining straps into the "D" rings. This poor design also increased the likelihood of the restraining straps being cut where they passed over the edge of the "I" beam. The recommended fix was to move the "D" rings to approximately one inch from the outer edge of the "I" beam and to weld the top of the "D" ring flush with the top edge of the "I" beam. This design change would also eliminate the

necessity to cut notches in the top portion of the "I" beam, as was done with the original design, to prevent the restraining straps from being cut by the outer edge of the "I" beam.

f. It was recommended that a second set of fork lift pockets, approximately the same width as the current pockets and located to the inside of these pockets, be added so that military rough terrain fork lifts can be used. The existing pockets, although in accordance with ANSI ISO standards, are not suitable for use with a military fork lift.

g. A gap approximately three inches wide appeared at the bottom of each end of the container when the container ends were in the raised position. The reason for this gap was not apparent. As this would be unacceptable for the shipment of secure cargo, it was recommended that this gap be eliminated.

PART II - RESULTS OF THE PHASE II DESIGN INTERMODAL AMMUNITION CONTAINER (AMCON) TESTS

OBJECTIVE

The objectives of the Phase II AMCON field tests were to:

1. Gather test data on the soldier-equipment interface for comparison with the test results of the Phase I AMCON to determine if the deficiencies noted in the Phase I design were corrected and,

2. Provide additional information for the assessment of the proof of principle and the operational feasibility of using an AMCON container for transport of ammunition and other commodities as a further enhancement of PLS capabilities.

METHODOLOGY

1. Test Participants: Test participants consisted of military and civilian personnel assigned to HEL with technical support by personnel from ASI Systems International (ASI), Aberdeen, MD.

2. Test Location: Tests were conducted at the U.S. Army Human Engineering Laboratory Logistics Technology Test Site, Aberdeen Proving Ground (Edgewood Area), MD.

APPARATUS

1. Equipment Used in the Test: The following equipment was used to support the test:

a. Palletized Loading System (Kenworth model)
b. Experimental Intermodal Ammunition Containers (AMCON)
c. 6000 lb Rough Terrain Fork Lift (RTFL)
d. 4000 lb Rough Terrain Fork Lift
e. Palletized and "dummy" ammunition
f. Stop watches
g. NATO standard cargo restraint straps

2. Precision of Equipment: All equipment used in the test was examined beforehand to assure satisfactory operating condition.

3. Safety Features of Equipment: All equipment used with the exception of the experimental AMCON and PLS were standard items which have been tested and safety certified. The PLS vehicles were previously used in tests by the U.S. Army and were safety certified at that time. The AMCON used in the test were built to military specifications and accepted by the U.S. Government prior to beginning the tests. The manufacturer also obtained ANSI ISO certification prior to delivery. Safety regulations governing the operation of military equipment were strictly enforced during the conduct of tests by the on-site Government safety officer.

DESCRIPTION OF EXPERIMENTAL TEST ITEM

Figure 4 is a photograph of the Phase II AMCON. The AMCON is an open sided intermodal container approximately 8 ft wide x 6 ft high x 20 ft in length.

Figure 4. Phase II AMCON

The Phase II AMCON is constructed of standard commercial grade structural steel with the exception of the floor which is hard wood. Both ends can be raised from the horizontal to the vertical position by one or two men for loading and folded back to the horizontal position for retrograde and storage. Although the AMCON is being designed and tested primarily for the movement of ammunition, it can carry other classes of supplies.

The Phase II prototype weighs approximately 5000 lb (tare weight) as compared with the Phase I prototype which weighed approximately 6062 lb. The cargo capacity of the Phase II design is approximately 20 short tons, 3 1/2 tons in excess of the load carrying capacity of the PLS. (The Phase I AMCON had a design capacity of approximately 26 short tons.) While the Phase I design had an "A" frame with a lifting bail bar on both ends, the Phase II design has the "A" frame and lifting bail bar on one end only (the same as the PLS flatrack). The original design of the AMCON was not compatible with the NATO standard features of the LHS on the PLS. The rear end of the AMCON can be folded either inward for stacking purposes or outward to serve as a ramp for ease of uploading disabled vehicles for retrograde. Other improvements include a new spring design used to facilitate raising and lowering the ends and a redesign of the locking pins used to lock the ends of the container in a vertical position. Two men were required to raise and lower the ends of the Phase I design. Although the ramp end of the Phase II AMCON can be raised and lowered by one individual, two individuals are still required to raise and lower the end with the lifting bail bar. The "D" rings mounted along the outside edges of the AMCON base have been inset approximately 1/2 in from the outside edges. Although this change somewhat improves the capability to secure a load with minimum time and effort, further improvements can be achieved by either mounting the "D" rings flush with the outside edges or grinding 1/2 in off of the top outer edge of the "I" beam. NOTE: UPON COMPLETION OF THE FIELD TESTING THE MANUFACTURER GROUND 1/2 IN OFF OF THE TOP OUTER EDGE OF THE I BEAM WHICH CORRECTED THE DEFICIENCY. The three-inch gap along the lower center portion of each end of the Phase I design and the gull wing covers have been eliminated in the Phase II design. Table 1 provides a quick comparison of Phase I versus Phase II characteristics.

Table 1. Phase I AMCON versus Phase II AMCON

Characteristic	Phase I Design	Phase II Design
Tare Weight	≈6062 lb	≈5000 lb
Cargo Carrying Capacity	≈26 tons	≈20 tons
Stacking Capability (Fully Loaded)	9 high	9 high
Raise and Lower Folding Ends	2 men required	2 men required*
"D" Rings for Fastening Cargo Straps	Inside offset mount	Reduced offset mount
Folding Ramp (One End)	No capability	Capability
Cargo Covers	Poor design	No capability

*Although two men are still required to raise and lower the lifting end of the Phase II AMCON, it is believed that more accurate adjustment of the counterbalance spring or replacement with a different type spring would reduce the amount of effort required to raise and lower the two ends of the AMCON.

Table 2 is a summary comparison of the capabilities of the Phase II AMCON with the regular PLS flatrack.

Table 2. Phase II AMCON versus Regular PLS Flatrack

Capabilities	AMCON	Regular Flatrack
Fully PLS Compatible	Yes	Yes
Storage Pockets for Cargo Straps	No	No
Container Ship Compatibility	Yes	No
Compatibility with Standard Port Cranes	Yes	No
Stackable	Yes	No
Folding Ends	Yes	No
Folding Ramp End	Yes	No
Integral Cargo Cover	No*	No

*Design can accommodate an ICC approved cover from which it can be determined whether or not the cargo has been tampered with enroute.

As the AMCON is still in the development cycle, specific nomenclature has not yet been assigned to the components of the item. Figures 5, 6 and 7 are simplified line drawings (not to scale) which show, respectively, the Ramp end, lifting end, and side of the Phase II AMCON with the component nomenclature used in this report.

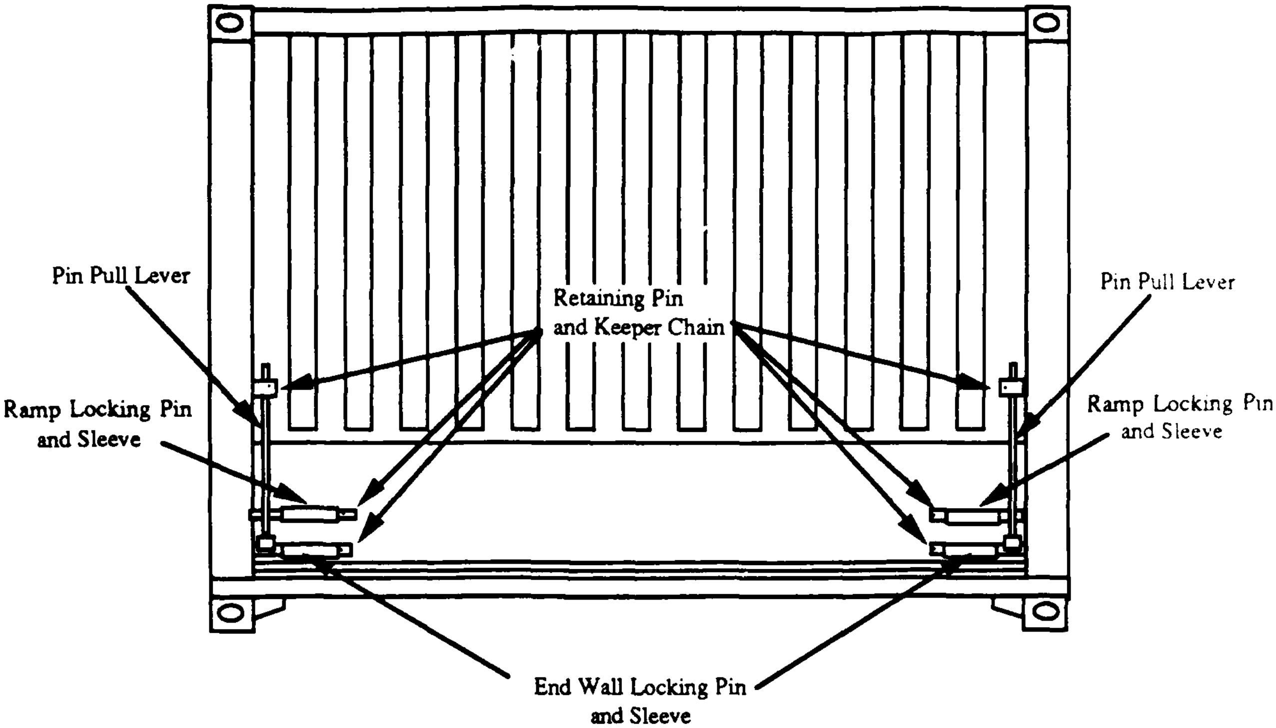

Figure 5. Ramp end

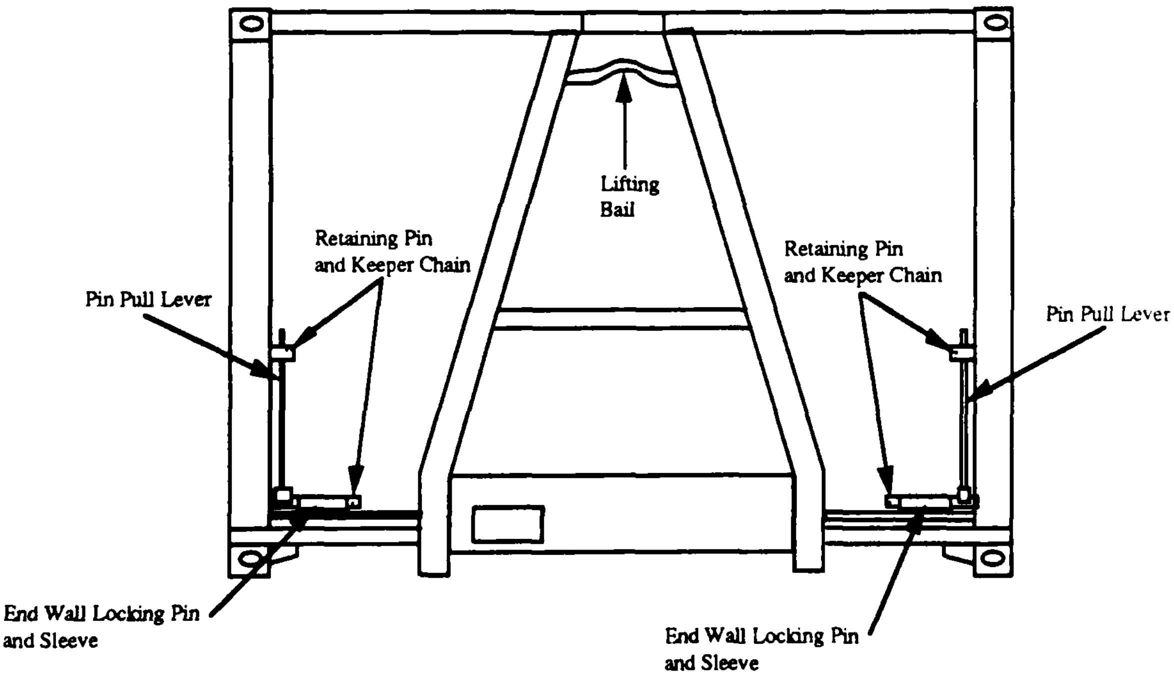

Figure 6. Lifting End

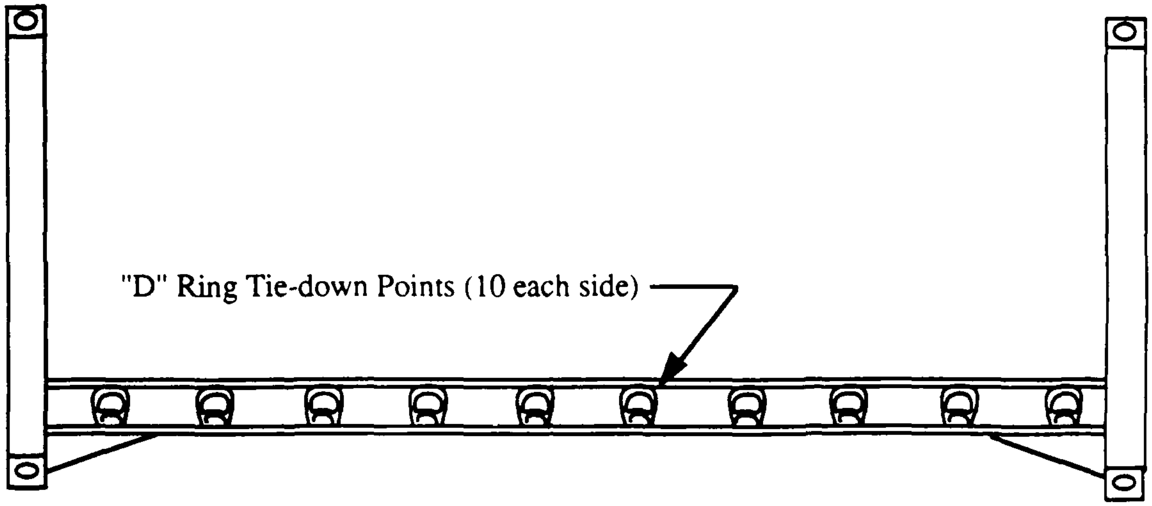

Figure 7. Side

DESCRIPTION OF TEST LAYOUT

Figure 8 is a schematic of the Logistics Technology Test Site which includes the equipment layout used to conduct the Phase II AMCON field trials. Prior to starting the test, two AMCON were loaded with approximately 23,150 lb of palletized "dummy" ammunition [10 pallets of weighted PA 104 (105-mm tank containers) and secured by cargo straps.] The gross weight of each loaded AMCON (tare weight of AMCON plus weight of cargo) was approximately 28,150 lb. (See loading diagram for AMCON at Figure 9.) The loaded AMCON were placed in a field perpendicular to a dirt road. A PLS vehicle with the flatrack removed was placed across the dirt road in line with each of the AMCON and approximately 15 ft forward of the front edge of the AMCON.

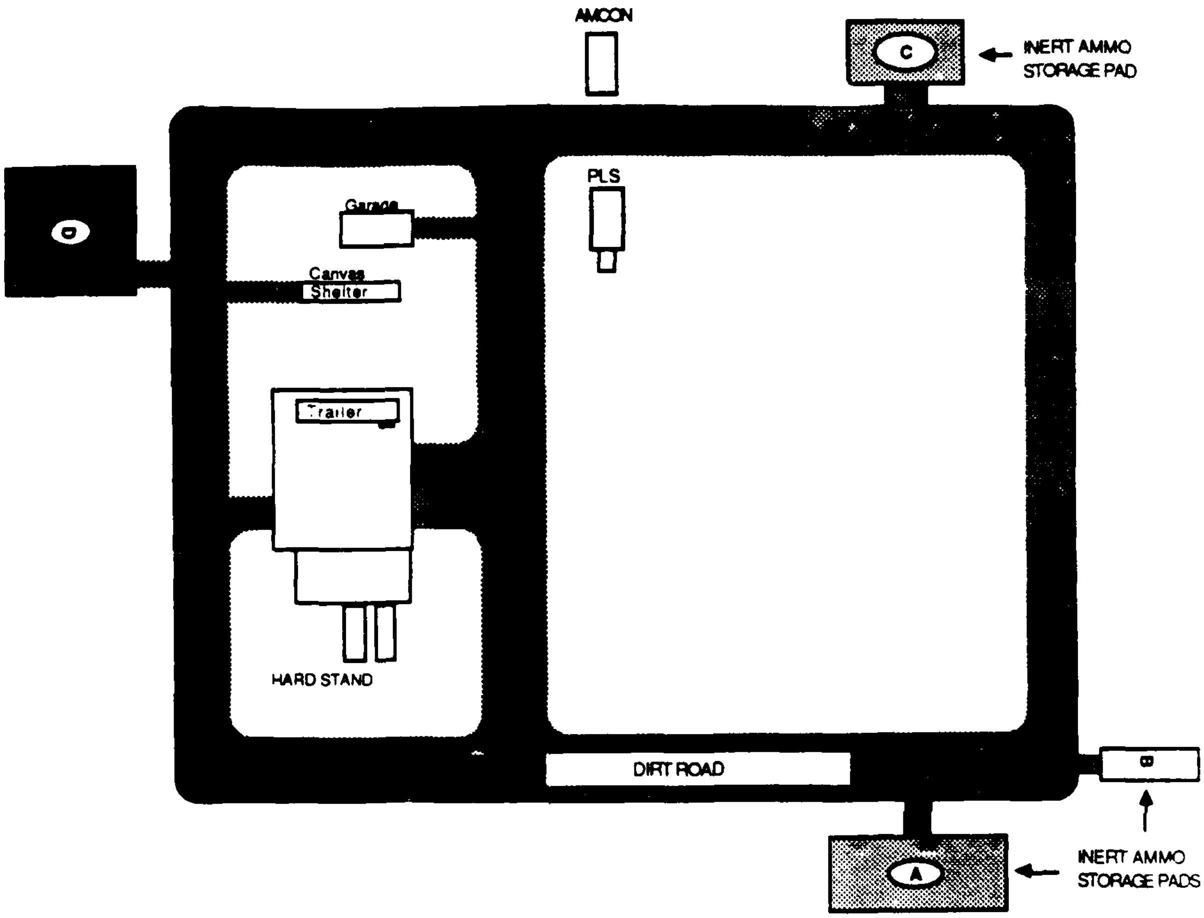

Figure 8. Field Test Layout

Front	PA 104 (105-mm tank) Containers	Rear
	PA 104 (105-mm tank) Containers	

Figure 9. AMCON Loading Diagram

TEST OBJECTIVES, TEST RESULTS AND ANALYSIS

1. Subtest #1 - Raise and Secure AMCON Ends.

a. Test Objective: The objective of this series of trials was to validate the design principle of the two folding ends of the AMCON. Of particular concern were the soldier-equipment interfaces. Also of concern was the time and number of personnel required to perform this task. NOTE: BASED ON EXPERIENCE WITH THE PHASE I DESIGN, TWO PERSONS WERE USED TO RAISE AND SECURE THE AMCON ENDS DURING THE ORIENTATION TRIALS. ALTHOUGH ONE MAN WAS ABLE TO RAISE AND LOWER THE RAMP END OF THE CONTAINER WITH SOME DIFFICULTY, TWO MEN WERE STILL REQUIRED TO RAISE AND LOWER THE END WITH THE PLS LIFTING BAIL. THEREFORE, TWO MEN WERE USED DURING THE TIMED TRIALS, AS WAS THE CASE WITH PHASE I DESIGN TRIALS.

b. Test Procedure: Two-person teams were used to raise the ends of the AMCON and lock them in place. ASI Systems International (ASI) provided time keepers and other technical support. Data sheets (Enclosure 1 to Appendix A) were used to record the times required for each trial and other specified information. One test participant was stationed on the ground on each side of one end of the AMCON with the end walls folded inward. On signal from the time keeper, the two men proceeded to lift one end of the container and lock it in place and then moved to the other end and performed the same function. "Time Stop" was recorded when the second end of the container had been raised and locked in place.

c. Subtest #1 Results: Table 3 shows the results of the timed trials.

Table 3. Raise and Secure AMCON Ends

TRIAL	TIME (Min)	TRIAL	TIME (Min)
1	.87	7	.70
2	.73	8	.90
3	.80	9	.57
4	.77	10	.85
5	.73	11	.52
6	.80	12	.50

Mean: .73 Standard Deviation: .13

d. Analysis of Test Results: The mean time to raise the two ends from the folded position to the vertical, or operational mode, and lock them into place was 0.73 minutes as compared with 0.87 minutes for the Phase I AMCON. This represents a 16% improvement. It is believed that the primary reason for this reduction is the lighter weight of the ends and the improvement in the design of the locking pins. Because the total time to perform this function is less than one minute, the improvement is considered insignificant. Although further design changes may improve the soldier-equipment interface and perhaps the Reliability, Availability, and Maintainability (RAM) characteristics, redesign aimed at further reducing the time required to perform this function is not warranted. Suggested minor changes in design to improve the soldier-equipment interface and/or RAM characteristics are contained in the "Recommendations" paragraph. Results of tests confirm the design principal of the folding ends of an Intermodal Ammunition Container.

2. Subtest #2 - Upload and Download AMCON

a. Test Objective: The objectives of these trials were to validate the design principle, the operational feasibility of the Phase II AMCON, and the compatibility of the AMCON with the PLS vehicle. Of particular interest was the soldier-equipment interface. Also of interest were the times required to perform the required tasks in comparison with the times required for the Phase I AMCON.

b. Test Procedure for Upload: The team for the upload portion of each trial consisted of a PLS driver and assistant driver. ASI Systems International provided time keepers and other technical support. Data sheets (Enclosure 1 to Appendix A) were used to record the times for each trial and other specified information. On signal from the time keeper, the assistant driver stood on the ground and directed the driver to back the PLS vehicle towards the end of the loaded AMCON. When it was within approximately 12 inches from the end of the container, the driver lowered the LHS hook and slowly backed the vehicle until the hook was underneath the bail bar. He then activated the LHS using the automatic mode (Position #1 on the console) to load the AMCON onto the vehicle in the same manner used to upload the regular PLS flatrack. "Time Stop" was recorded when the container was completely loaded on the vehicle and the vehicle began to move forward.

c. Test Procedure for Download: The procedure for download was exactly the opposite of that described above for the upload portion of the trial. The trial started with the AMCON located on the PLS. The driver was in the cab and the assistant driver was on the ground near the side of the PLS truck. On signal from the time keeper, the driver began downloading the AMCON using the automatic mode (Position #1 on the console). When the AMCON was on the ground, the assistant driver signaled the driver to lower the hook on the LHS and move forward. Time Stop was recorded soon as the hook was free of the grounded AMCON.

d. Subtest #2 Results: Table 4 shows the results of Subtest #2 trials.

Table 4 - Upload and Download AMCON

TRIAL	TIME (Min) Upload	Download	TRIAL	TIME (Min) Upload	Download
1	1.73	1.65	14	1.45	1.31
2	1.33	1.36	15	1.28	1.56
3	1.63	1.58	16	1.63	1.55
4	1.43	1.55	17	1.35	1.41
5	2.15	Abort*	18	1.61	1.43
6	1.56	1.50	19	1.48	1.46
7	1.36	1.41	20	1.33	1.35
8	1.75	1.53	21	2.08**	1.58
9	1.48	1.38	22	2.28***	1.65
10	1.26	1.38	23	1.35	1.35
11	1.61	1.46	24	1.30	1.38
12	1.63	1.70	25	1.45	1.40
13	1.88	1.46	26	1.41	1.48

Upload Mean: 1.57 Standard Deviation: .20
Download Mean: 1.47 Standard Deviation: .11

* During upload, driver error resulted in repositioning PLS Truck. Time was recorded, however, downloading was not accomplished during this trial.

** During upload, driver error resulted in repositioning PLS truck to complete the operation.

*** Driver error regarding PLS transmission position (should have placed transmission in neutral rather than reverse) during upload resulted in repositioning PLS truck to complete the operation.

e. Analysis of Test Results: The mean time for uploading the Phase II AMCON was 1.57 minutes as compared with 1.68 minutes for the Phase I AMCON. The mean time for downloading the Phase II AMCON was 1.47 minutes as compared with 0.99 minutes for the Phase I AMCON. The raw data from the Phase I tests were reexamined to determine why the mean time for downloading the Phase II AMCON was longer than that for the Phase I AMCON. It was determined that the procedures used for the Phase I tests were slightly different than for the Phase II tests. For the downloading cycle of the Phase I AMCON, "Time Start" was recorded on signal from the time keeper as was done for Phase II trials. "Time Stop", however, was recorded when the container reached the ground and the LHS hook was disengaged from the container. The hook was not returned to the on-vehicle storage position. In the Phase II trials, the LHS hook was disengaged from the container and then returned to the on-vehicle storage position before "Time Stop" was recorded. It was determined through timed trials that the average time required to raise the LHS hook from the hookup level to the on-vehicle storage position was approximately 40 seconds. Therefore, in order to make a comparison between the two sets of data, 40 seconds were added to each of the Phase I download times. This recomputation resulted in raising the mean time for Phase I downloading from 0.99 minutes to 1.66 minutes. The comparison then becomes 1.47 minutes for downloading the Phase II AMCON as compared to 1.66 minutes for downloading the Phase I AMCON. The differences in times for uploading and downloading the Phase I AMCON in comparison with the Phase II AMCON are considered insignificant. Since the times for uploading either the Phase I or Phase II AMCON are comparable to the times for uploading and downloading the regular PLS flatrack, it can be concluded that the times and skills for uploading and downloading the AMCON compare favorably with the times and skills required for uploading and downloading the regular PLS flatrack. Proof of principal for the AMCON is therefore confirmed.

3. Subtest #3 - Lower and Raise the AMCON Ramp

a. Test Objective: One end of the Phase II AMCON was constructed so that it could either be folded inward for stacking or outward to form a ramp to load disabled vehicles and other equipment for retrograde. The objective of these trials was to validate the design principle and the operational feasibility of using the Phase II AMCON ramp capability to retrograde light wheeled vehicles and other disabled equipment. Of particular

interest was the soldier-equipment interface and the times required to convert the AMCON from an ammunition transporter to a disabled equipment transporter.

b. Test Procedure: This function required two men to disengage the locking pins used to hold the ramp end of the AMCON in the vertical position and lower the end outward to form a ramp. Data sheets (Enclosure 1 to Appendix A) were used to record the times required for each trial and other specified information. "Time Start" was recorded on signal from the time keeper. Each team member disengaged a locking pin using the pin puller bar. They then grasped the top of the end wall, pulled it outward and lowered it to the ground. "Time Stop" was recorded when the ramp was on the ground. This procedure was reversed to raise the ramp from the horizontal to the vertical position and lock it in place.

c. Subtest #3 Results: Table 5 shows the results of Subtest #3 trials.

Table 5. Lower and Raise AMCON Ramp

TRIAL	TIME		TRIAL	TIME	
	Lower	Raise		Lower	Raise
1	.28	.37	8	.33	.27
2	.40	.37	9	.29	.37
3	.32	.38	10	.45	.27
4	.40	.37	11	.33	.25
5	Abort*	.32	12	Abort*	Abort*
6	.33	.55	13	.27	.27
7	.28	.30			

Lower Mean: .33 Standard Deviation: .06
Raise Mean: .34 Standard Deviation: .08

* Bushings fell out of pin pulling bar.

d. Analysis of Test Results: The mean time to lower the Phase II AMCON ramp was .33 minutes. The mean time to raise the ramp was .34 minutes. The standard deviations of .06 for lowering and .08 for raising support the contention that this is a very

simple operation. When the ramp end wall was folded outward, a 4000 lb Rough Terrain Fork Lift (RTFL) was loaded on the AMCON (see at Figures 11 and 12).

Figure 10. RTFL Being Loaded

Figure 11. RTFL Loaded and Ready for Tie Down

The ramp end of the AMCON is approximately 9 inches thick. Therefore, the use of a log, loose boards or similar items laid at the end of the ramp to form a temporary incline will facilitate loading a disabled vehicle.

DESIGN DEFICIENCIES

The following design deficiencies were noted during the field testing of the Phase II AMCON:

1. The links of the chains which capture the small pins used to secure the pin pulling levers and the end wall locking pins in place are excessively large. This restricts the flexibility of the chain making it difficult to insert and remove the pins. These chains should be replaced by a chain with smaller links or a thin cable.

2. The small pins with the self contained keepers used to secure the pin pulling lever and the end wall locking pins in place are extremely difficult to remove, especially by an individual wearing gloves. These pins should be replaced with detent type pins that can be easily inserted and removed by a person wearing gloves.

3. The 3/8 in diameter bolts welded to the ends of the end wall locking pins to prevent the locking pins from being completely removed from their keepers are of inferior quality. Two of them broke during the early phases of the field testing. A small 90 degree steel keeper mounted with two bolts on the base of the end walls of the container should provide a more effective method of retaining the locking pins from being completely removed (and lost).

4. The male projections on the ends of the pin pulling levers should be manufactured from a harder grade of steel or hardened to preclude excessive wear. After only a dozen trials, the male projections on the pin pulling levers showed excessive wear. This made it difficult to remove and reinsert the end wall locking pins.

5. Although the Government contract called for the "D" rings used to anchor the cargo restraint straps to be mounted flush with the outside edge of the container base, the fasteners were again welded approximately 1/2 in inside the outer edge of the container base. This resulted in excessive wear on the cargo restraint straps where they passed across the sharp edge of the "I" beam forming the outside frame of the container base. The manufacturer's proposed fix was to cut a 1/2 in off the top of the outer edge of the "I" beam which corrected the problem.

6. Because of the poor performance of the counterbalance springs used in the Phase I AMCON to assist in raising and lowering the end walls, the Phase II design used a completely different spring arrangement with a cable attachment. Not withstanding this

design change, two individuals were still required to perform this operation on the Phase II Design AMCON. It was possible, however, for one team member to lift and lower the ramp end because it was significantly lighter than the lifting end. The wheel fixture, on which the cable attached to the counterbalance spring, was mounted on the inside of the end wall of the ramp end in a manner which, when the ramp was lowered, the cable assembly projected approximately 5 in above the ramp. This would interfere with the loading of disabled equipment.

It is suggested that correction of the counterbalance spring problem may be solved by either a better adjustment of the tension on the spring, replacement with a spring having different tension limitations, or complete redesign along the lines of the commercial ANSI ISO flatracks with folding ends.

Correction of the protrusion of the counterbalance spring assembly mounted in the ramp end may be possible by simply recessing the counterbalance spring assembly further into the end wall. If this changes the center of gravity, this change would not work.

7. As the emergency bail bar for uploading stacked AMCON with folded end walls onto the PLS was not available for testing, the functioning of this item should be tested by the Government prior to final acceptance of the Intermodal Ammunition Containers.

CONCLUSIONS

1. General:

The use of the Intermodal Ammunition Container (AMCON) as a subsystem of the Palletized Loading System (PLS) significantly enhances the overall capability of the PLS by providing a container that is compatible with port container cranes and intermodally compatible with container ships and supporting transport equipment. It would be possible to load an AMCON at the ammunition manufacturing plant, move it to the port via PLS vehicles or other means, load it onto container ships, offload it at an overseas port, and move it forward to a using unit by PLS without having to transload the cargo enroute from one type of container to another.

2. Specific:

The Phase II AMCON is superior in design and performance in comparison with the Phase I design because:

a. It is approximately 1062 lb lighter.

b. The ends can be more easily raised from the horizontal to the vertical (operational) position by two individuals in less than a minute.

c. One end can be quickly folded outward to form a ramp for ease of loading disabled vehicles and similar cargo for retrograde by the PLS. (The Phase I design did not have this capability.)

d. It continues to be completely compatible with the LHS used on the PLS similar to the Phase I AMCON.

e. The "D" rings used for attaching cargo restraint straps provide the flexibility to readily secure other types of cargo with varying configurations for transport on the AMCON by the PLS.

RECOMMENDATIONS

It is recommended that:

a. Copies of this report be provided the appropriate TRADOC organizations for development of supporting Organizational and Operational (O&O) Plans and the establishment of quantitative requirements.

b. The Level I drawings of the Phase II AMCON be turned over to the appropriate U.S. Army Materiel Command (AMC) Research and Development Command for development and fielding of the AMCON as part of the Palletized Loading System.

c. The following minor design changes for improving the RAM characteristics and the soldier-equipment interfaces be considered by the AMC Development Command for incorporation into the final design of the production model of the AMCON:

(1) Change the large link chains used to capture the small locking pins that hold the pin pulling bar in the storage position and the small pins used to hold the end wall locking pins in place to small link flexible chain or thin cable.

(2) Change the small retaining pins with self contained keepers (T pins) used to secure the pin pulling lever and the end wall locking pins to detent type pins.

(3) Replace the 3/8 in diameter bolts welded to the ends of the end wall locking pins with 1/4 in angle iron bolted to the bottom portion of the side wall of the container ends.

(4) Fabricate the male projections of the pin pulling bar and the end wall locking pins from stronger steel or case harden them to prevent excessive wear.

(5) Cut approximately 1/2 in off the top outer portion of the "I" beam on the floor of the AMCON so that the "D" rings used to anchor the cargo restraining straps are flush with the outer edges of the sides of the container floor to preclude excessive wear on the cargo restraining straps.

(6) Redesign the counterbalance spring assemblies to enable one man to lift the end walls and to preclude interference with the loading of disabled equipment over the ramp end of the container.

(7) Perform limited field testing of the emergency bail bar used to upload stacked AMCON onto a PLS vehicle.

END